NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

WATER WELL

(No.)
CODE 642

DEFINITION

A hole drilled, dug, driven, bored, jetted or otherwise constructed to an aquifer.

PURPOSE

Provide water for livestock, wildlife, irrigation, human, and other uses.

Provide for general water needs of farming / ranching operations.

Facilitate proper use of vegetation on range land, pastures, and wildlife areas.

CONDITION WHERE PRACTICE APPLIES

This practice applies on all land uses where the underground supply of water is sufficient in quantity and quality for the intended purpose.

This practice standard applies only to production wells. Specifically excluded are any types of wells installed solely for monitoring or observation purposes, injection wells, and piezometers. The standard does not apply to:

- Pumps installed in wells,
- Above ground installations, such as pumping plants, pipelines, and tanks; temporary test wells; and decommissioning of wells (ASTM D 5299).

CRITERIA

Potential effects of installation and operation of the well on cultural, historical, archeological, or scientific resources at or near the site shall be considered in planning.

Suitability of Site. The availability of ground water for its intended use at the site shall be determined by using reliable local experience and reviewing all available relevant geologic maps and reports; well records maintained by state and federal agencies; and design, construction, and maintenance records of nearby wells. An appropriate level of investigation, including test well drilling, is conducted on-site, as needed, prior to well construction to determine site-specific hydro-geologic conditions.

Site Preparation. Clear all trees, brush, and obstacles from the well site prior to setting the drill rig. The area immediately surrounding the well site shall be smoothed and graded to allow for a safe and dry working area.

Sanitary Protection. Wells shall be located at safe distances from any potential sources of contamination or pollution, including unsealed abandoned wells. The allowable distance shall be based on consideration of site-specific hydro-geologic factors and shall comply with requirements of all applicable state or local regulations or construction codes.

Wells should be located a safe distance from sources of contamination. **Table 1** shows the minimum setback requirement for installation of wells.

Table 1
Minimum Horizontal Distance between Well-head and Source of Contamination (Feet)

Source of Contamination	Minimum Distance
Waste Disposal Lagoon	**300**
Cesspool	**150**
Silo Pit, Seepage Pit	**150**
Livestock and Poultry Yards	**100**
Manure Pile, Privy	**100**
Septic Tank and Disposal Field	**100**
Gravity Sewer or Drain	**50**
Standing Water	**10**

Provisions shall be made to exclude all surface runoff and drainage

water from within ten feet of the wellhead. The level of protection will be as required by the 25-year 24-hour storm event.

The annular space around the casing shall be at least 3 inches and shall be filled with cement grout, bentonite clay, or other suitable materials to a depth that will seal off the surface waters.

Wellhead Protection. Wells shall be located safe distances from both overhead and underground utility lines and other safety hazards. Particular attention must be given to avoid petroleum and natural gas pipelines,

The well head must be reasonably protected from damage that might be incurred by livestock, vehicles, acts of carelessness, and vandalism.

Well Diameter. The diameter of the well shall be adequate to meet the yield capacity of the formation in relation to the nature and extent of the water bearing area and to permit the installation of a pump to deliver the needed amount of water to the projected lift elevation.

Bore Hole. Wells shall be sufficiently round, straight, and of adequate diameter, to permit satisfactory installation of inlet, well casing, filter pack, annular seal, and passage of tremie pipe (including couplings), if used.

Use of Casing. Casing shall be installed to seal out undesirable surface or shallow ground water and to support the side of the hole through unstable earth materials. The intake portion of a well through stable geologic formations may not require casing.

Casing selection for wells more than 1,000 feet in total depth will be considered Job Approval Authority Class VI.

Minimum Thickness of Well Casing. The maximum depth for well casings is the difference in static head between the inside and outside of the casing. The difference will probably be greatest during operation. Caution should be used in determining this difference in head, as it is rarely the total depth of the well.

The following Items influence head difference:

- Drilling method,
- Well yield, and
- Draw down of aquifer.

The minimum wall thickness for steel water well casings will be 3/16 inch. Use **Table 2**.

PVC plastic water well casings shall not be thinner than SDR (Standard Dimension Ratio) 26. Use **Tables 3, 4, or 5** as appropriate.

Well casing wall thickness shall be sufficient to withstand all anticipated static and dynamic pressures imposed on the casing during installation, well development, and use. The same wall thickness and material shall be used for the entire casing.

Casing Diameter. Casing diameter shall be sized to permit satisfactory installation and efficient operation of the pump, and large enough to prevent excessive head loss.

Casing Materials. Casings may be of steel, iron, stainless steel, copper alloys, plastic, fiberglass, or other material of equivalent strength and durability consistent with the intended use of the water and the maximum anticipated differential head between the inside and outside of the casing.

Asbestos cement pipe shall not be used.

Steel well casings shall meet or exceed requirements specified in ASTM A 589. Steel pipe manufactured for other purposes may be used if the quality of the pipe meets or exceeds requirements specified in ASTM A 589.

Plastic casings made of acrylonitrile-butadiene-styrene (ABS), polyvinyl chloride (PVC), or styrene-rubber (SR) shall conform to material, dimensional and quality requirements specified in ASTM F 480.

Plastic pipe manufactured for water or irrigation pipelines may be used if the quality exceeds or equals requirements specified in ASTM F 480.

Filament-wound fiberglass casings (glass-fiber-reinforced thermosetting resin pipe, RTRP) may be used if material meets requirements specified in ASTM D 2996. Tests for long-term cyclic pressure strength, long-term static pressure strength, and short-term rupture strength, as required in ASTM D 2996, are not needed because the pipe is to be used for well casing. Joints shall meet requirements specified in section 3.8, ASTM F 480. The

modulus of elasticity is certified for use in determining maximum depth.

Fiberglass pipe, (also called reinforced plastic mortar pipe (RPMP), or fiberglass pipe with aggregate) shall meet or exceed requirements specified in ASTM D 35l7.

RPMP casings shall meet or exceed the requirements specified in ASTM-D-3517.

The casing pipe, couplings, and screens shall be homogeneous throughout and shall be free of visible cracks, holes, foreign material, or other injurious defects. They shall be as uniform in color, density, and other physical properties as is commercially available.

Only steel pipe casings shall be used in driven wells.

To prevent galvanic corrosion, dissimilar metals shall not be joined.

Casing shall extend from at least one foot above the ground surface down to the required depth.

Perforated Casing. If perforated casing is used, the size of the perforations will be selected by the Contractor in accordance with this standard and approved by NRCS prior to installation.

Joint Strength. Joints for well casings shall have adequate strength to carry the load due to the casing length and still be watertight, or shall be mechanically supported during installation to maintain joint integrity. Such mechanically supported casings shall terminate on firm material that can adequately support the casing weight.

Filter Pack and Screen. The contractor and the supplier or manufacturer of the screen, if a screen is used, will select the screen and design the gravel pack. NRCS design approval must be obtained prior to installation.

Filter pack (Gravel pack) material shall extend through the length of the water-bearing formation and a minimum of 10 feet above the top of any perforated casing or screened section.

The pack shall be 3 to 12 inches thick and shall consist of sand or gravel material having a D30 grain size 4 to 12 times the D30 grain size of the aquifer material. It shall be carefully placed to prevent segregation and bridging.

The casing shall be centered in the filter pack such that an approximately equal amount of packing material is on all “sides” of the casing.

The size and gradation of the filter pack (gravel pack), if required, will be selected after samples of the aquifer have been obtained and analyzed. Installation of a filter pack around the well screen shall be required under the following conditions:

- Presence of a poorly graded, fine sand aquifer;
- Presence of a highly variable aquifer, such as alternating sand and clay layers;
- Presence of a poorly cemented sandstone or similar aquifer;
- A requirement for maximum yield from a low-yielding aquifer;
- Hole drilled by reverse circulation.

A well screen shall be installed in any earth material likely to produce silt or sand. Well screens may be constructed of commercially manufactured screen sections, well points, or field-perforated sections.

Perforation by any method is allowable with the following provisions:

- The screen openings, for uniform size aquifer material, are smaller than the average diameter of the aquifer material,
- The pipe is not damaged,
- The screen openings, for non-uniform aquifer material, are smaller than 60 percent of the aquifer material,
- The screen openings, for filter pack (gravel pack), will exclude at least 85 percent of the filter pack material,
- The length and open area of the screen can be sized to limit average entrance velocity of water into the well to less than or equal to 0.1 foot per second, and
- The required strength can be maintained.

The position of the screen in the well shall be determined by the depth of the aquifer below the ground surface and the thickness of aquifer

to be penetrated by the well. The top of the screen shall be located below the lowest water level expected in the well.

Grouting and Sealing. The annulus surrounding the permanent well casing at the upper terminus of the well shall be filled with expansive hydraulic cement (ASTM C 845), shrinkage-compensating concrete, bentonite-based grout, clay, or other material with similar sealing properties. The length of the grout seal shall be at least 10 feet and not less than the minimum specified in state or locally applicable construction codes.

A positive seal (grouted in place) or packer shall be provided between the casing and the less pervious material overlying the aquifer of artesian wells. A similar positive seal shall be provided to separate aquifers where co-mingling of waters is undesirable.

The casing shall be sealed at the ground surface by a 4-inch thick concrete slab extending at least 2 feet in all directions.

Each well shall be provided with a watertight cover or seal to prevent entry of contaminants into the well.

Seals (Packers). Telescoped screen assemblies shall be provided with one or more sand-tight seals between the top of the telescoped screen assembly and casing.

Pre-packed Well Screens. For heaving or caving sands, silty, or fine-grained aquifers, and for horizontal or angled wells, a commercial pre-packed well screen may be substituted for a conventionally installed (by tremie) filter pack.

Installation. Casing for artesian aquifers shall be sealed into overlying, impermeable formations in such a manner as to retain confining pressure.

If a zone is penetrated that is determined or suspected to contain water of quality unsuitable for the intended use, the zone shall be sealed to prevent infiltration of the poor-quality water into the well and the developed portion of the aquifer.

Aquifer Development. For massive, unfractured rock formations unresponsive to water well development procedures, the use of aquifer stimulation techniques may be considered to improve well efficiency and specific capacity. Depending on the composition and structure of the formation, techniques may include dry ice, acid, explosives, or hydro fracturing.

Well Development. Wells to be completed without a filter pack in unconsolidated granular aquifers shall be developed following guidance provided in ASTM D 5521, Standard Guide for Development of Ground-Water Monitoring Wells in Granular Aquifers. The method shall be selected based on geologic character of the aquifer, type of drilling rig, and type of screen.

The well shall be developed at 120 percent normal anticipated production until it stops producing excessive quantities of solid particles.

Disinfection. Wells shall be disinfected immediately following their construction or repair to neutralize any contamination from equipment, material, or surface drainage introduced during construction. The disinfection process shall comply with all local or state requirements.

Riser Pipe. Friction loss for plastic pipe may be computed using the Hazen-Williams equation and a roughness coefficient, “C”, equal to 150 or the Manning’s equation and a roughness coefficient, “N”, equal to 0.009.

All pipe must be designed to withstand the pressure it will be subjected to, including hydraulic transients, internal and external pressures, surge, and water hammer.

Watertight joints that have strength equal to that of the pipe shall be used. Couplings must be of material compatible with that of the pipe. If they are made of material susceptible to corrosion, provisions must be made to protect them.

Static pressure shall not exceed the pressure rating of the pipe. The normal working pressure shall not exceed 72% of the pressure rating of the pipe.

Steel pipe shall meet the requirements of AWWA Specification C-200.

Access Port. An access port with a minimum diameter of 0.5 inch shall be installed to allow for unobstructed measurement of depth to the water surface, or for a pressure gage for

measuring shut-in pressure of a flowing well. Access ports and pressure gages or other openings in the cover shall be sealed or capped to prevent entrance of contaminants into the well. Removable caps are acceptable as access ports.

Markings. Plastic pipe meeting any of the above standards shall include the following markings:

- The nominal pipe size; e.g., 6 inches.
- The type of plastic pipe material in accordance with the designation as shown above; e.g., PE3408.
- The pressure rating in psi at 23 degrees Celsius (73.4 degrees Fahrenheit).
- The ASTM specification with which the pipe complies; e.g., D 3035.
- The manufacturer's name (or trademark) and code.
- The seal of approval of the National Sanitation Foundation (NSF),

All markings shall be spaced at intervals along the pipe, not to exceed five feet.

Certification. The markings indicating the manufacturer, size, and compliance with appropriate specification can be accepted as evidence that the material meets the requirements of this standard and specification. Absent the makings, the supplier must certify that the material complies with the requirements of this standard and specification and submit the certification to the State Conservation Engineer. The SCE can request test results supporting the certification.

Water Quality Testing. Sampling and testing shall comply with all applicable federal and local requirements. These requirements vary according to the quality parameters associated with the intended use(s) of the water.

CONSIDERATIONS

If practicable, wells should be located on higher ground and up gradient from sources of contamination or flooding.

The design flow velocity of the riser pipe at system capacity should not exceed 5 ft/sec to reduce friction loss.

The potential for adverse interference with existing nearby production wells should be evaluated in planning.

The potential for ground water overdraft and the long-term safe yield of the aquifer should be considered in planning.

PLANS AND SPECIFICATIONS

Plans and specifications shall be prepared for specific field sites in accordance with this standard and shall describe the requirements for applying the practice to achieve its intended uses.

OPERATION AND MAINTENANCE

A plan for maintenance of a well shall be prepared. The well construction records shall be kept on file with the maintenance plan by the owner/operator. As a minimum, the plan shall include a statement of identified problems, corrective action taken, date, and specific capacity (yield per unit draw-down) of well before and after corrective action was taken.

The well site must be readily accessible for, drilling, operation, maintenance, and repair.

REFERENCES

NRCS Engineering Field Manual

NRCS Practice Standard Code 516, Pipeline

ASTM Specifications

AWWA Specifications

Table 2

Maximum Depth of Installation for Steel Casings (Feet)

Wall Thickness (in)	Casing Size (in)					
	8	10	12	14	16	18
3/16	**1,650**	**840**	**500**	**370**	**250**	**170**
7/32	-	**1,340**	**800**	**600**	**400**	**280**
1/4	-	-	**1,190**	**890**	**600**	**420**
9/32	-	-	-	**1,280**	**850**	**590**
5/16	-	-	-	-	**1,170**	**820**
11/32	-	-	-	-	-	**1,100**

Table 3

Well Casing Requirements for PVC and ABS Pipe

Pipe Markings			Properties	
Specification	Designation Code	Material Specification	Cell Classification (Former Type and Grade)	Modulus of Elasticity
PVC				
D 1785 or D 2241	**PVC 1120**	**D 1784**	**12454B (Type 1, Grade 1)**	**400,000**
D 1785 or D 2241	**PVC 1120**	**D 1784**	**12454C (Type 1, Grade 2)**	**400,000**
D 1785 or D 2241	**PVC 2110**	**D 1784**	**14333D (Type 11, Grade 1)**	**320,000**
D 1785 or D 2241	**PVC 2112**	**D 1784**	**14333D (Type 11, Grade 1)**	**320,000**
D 1785 or D 2241	**PVC 2116**	**D 1784**	**14333D (Type 11, Grade 1)**	**320,000**
ABS				
D 1527 or D 2282	**ABS 1316**	**D 1788**	**3-5-5 (Type 1, Grade 3)**	**250,000**
D 1527 or D 2282	**ABS 2112**	**D 1788**	**4-4-5 (Type 2, Grade 1)**	**250,000**

ABS Pipe D-1527 or D-2282 with a designation code of ABS 1208 or ABS 1210 does not meet the minimum strength requirements of ASTM-F-480

Considering Cell Classification, the letter designation is for chemical resistance. "A" has the most resistance and "D" the least. ASTM-F-480 requires "C" or "D"; therefore, "B" exceeds the requirements.

NRCS, NM
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Use the Modulus of Elasticity and SDR marked on the pipe to determine the maximum allowable depth from **Table 4.**

Table 4

Maximum Depth of Installation for Plastic Pipe (Feet)

Modulus of Elasticity SDR	500,000	400,000	320,000	300,000	250,000	200,000
26	**160**	**127**	**100**	**94**	**78**	**66**
21	**310**	**245**	**195**	**180**	**152**	**120**
18	**500**	**390**	**320**	**290**	**250**	**195**
13.5	**1,200**	**950**	**760**	**720**	**600**	**470**

Table 5

Maximum Depth of Installation for Schedules 40, 80, and 120 Plastic Pipe, E = 400,000 (Feet)

Nominal Diameter	Schedule 40	Schedule 80	Schedule 120
2	**650**	**1,960**	**3,020**
2 ½	**840**	**2,260**	**2,920**
3	**550**	**1,550**	**2,560**
3 ½	**420**	**1,220**	**1680**
4	**340**	**1,010**	**2,330**
5	**230**	**740**	**1,830**
6	**170**	**660**	**1,510**
8	**120**	**450**	**1,430**
10	**90**	**390**	**1,160**
12	**-**	**360**	**1,160**

The values are for PVC with a Modulus of Elasticity of 400,000. For PVC with a Modulus of Elasticity of 320,000, multiply the above values by 0.8 and for ABS pipe having a Modulus of Elasticity of 250,000, use 0.625.